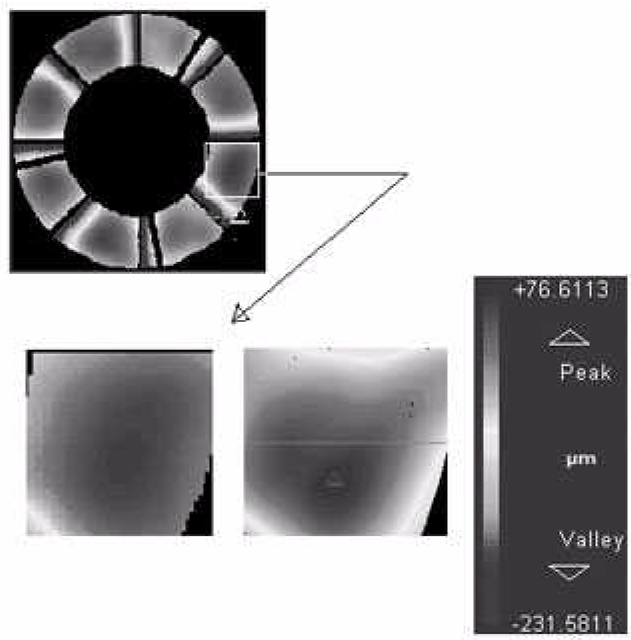
White Light Used to Enable Enhanced Surface Topography, Geometry, and Wear Characterization of Oil-Free Bearings



Surface topography of one of eight foil air thrust bearing pads. Left: Before test run. Right: After 100 start/stop cycles.

A new optically based measuring capability that characterizes surface topography, geometry, and wear has been employed by NASA Glenn Research Center's Tribology and Surface Science Branch. To characterize complex parts in more detail, we are using a three-dimensional, surface structure analyzer-the NewView5000 manufactured by Zygo Corporation (Middlefield, CT). This system provides graphical images and high-resolution numerical analyses to accurately characterize surfaces. Because of the inherent complexity of the various analyzed assemblies, the machine has been pushed to its limits. For example, special hardware fixtures and measuring techniques were developed to characterize Oil-Free thrust bearings specifically. We performed a more detailed wear analysis using scanning white light interferometry to image and measure the bearing structure and topography, enabling a further understanding of bearing failure causes.

The system consists of two parts-a microscope and a high-end computer. Light directed through the microscope is split within the interferometric objective (lens). One portion is reflected off a highly polished internal reference surface in the objective and the other is reflected off the part to be measured. Both reflections are then captured by a solid-state camera that "sees" an interference between the two light wavefronts that results in dark and light bands called fringes. These fringes are analyzed and quantified into the surface topography of the part. Depths up to 100 μm (3937 μin.), with 0.1 nm (0.0039 μin.) vertical resolution and 0.4 nm (0.157 μin.) root mean square repeatability, are imaged independently of objective magnification. Lateral resolution, which depends on the pixel size from the field of view of the objective in use, ranges from 0.45 μm (17.7 μin.) at ×100 to 11.8 μm (464.5 μin.) at ×1. The data, which are collected without contacting the specimen, represent a wide dynamic range without affecting or damaging the surface of interest. Before and after test run images of a bare Inconel thrust bearing (see the figure) show the enhanced range of this system to determine more clearly the failure mechanisms involved.

With this system, noncontacting three-dimensional surface topography and geometric measurements of up to 5 in. in diameter have been done by stitching together the numerous microscope scans required to image the whole part. This capability is far better than using a diamond stylus in one dimension, which is very limited in size and can affect the surface and/or measurement because of its necessary contact with the part. Using this optical method, one can determine a correlation between geometry, surface topography, and running/life performance from one bearing to another and investigate manufacturing quality control effects.

Find out more about Oil-Free Turbomachinery research
http://www.grc.nasa.gov/WWW/Oilfree/.

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